USA National Phenology Network

# *Phenology as an integrator across scales, audiences and approaches to science*

RISE Symposium
October, 12th 2013

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Photo credit: L. Barnett

Photo credit: P. Warren

# What is phenology?


***…it is the study of recurring plant and animal life-cycle stages, or* phenophases*, and their relationship to environmental conditions.***

*The science of the seasons*

- Leafing and blooming
- Hibernation, migration, emergence
- Easy to observe

# USA National Phenology Network

## Primary goal

- Understand how plants, animals & landscapes respond to climatic variation and change.
- ***Create a standardized dataset to support research.***

## Mission

- Make phenology data, models and related information available to scientists, resource managers and the public.
- Encourage people of all ages and backgrounds to observe and record phenology.

A NATIONAL NETWORK OF INTEGRATED PHENOLOGICAL OBSERVATIONS ACROSS SPACE AND TIME.

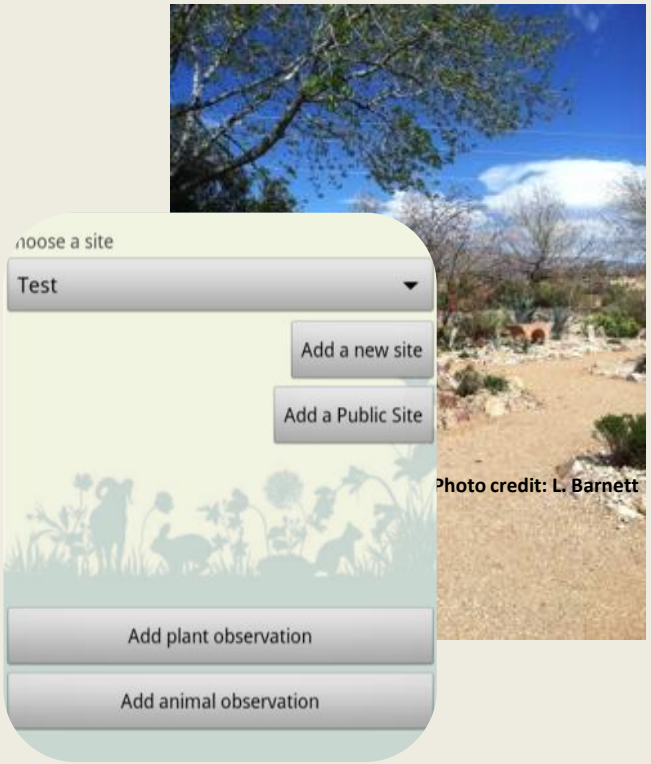

usanpn.org

# nature's notebook

A project of the USA-NPN

USA npn National Phenology Network — Taking the Pulse of Our Planet

USGS science for a changing world




A **multi-taxa**, **national-scale**
Plant and animal phenology observation program

- Standardized protocols
- Web and mobile apps for data entry
- Data download and visualization
- 3,000 observers reporting on 650 plant and 250 animal species

TRACKING Seasonal CHANGES IN PLANTS AND ANIMALS

***Nature's Notebook***
is for scientists, naturalists, volunteers, land managers, park rangers, and YOU!

# Data visualization

GRL | Geophysical Research Letters

Regular Article

**Predicting changes in temperate forest budburst using continental-scale observations and models**

Su-Jong Jeong[1,*], David Medvigy[1], Elena Shevliakova[2], Sergey Malyshev[2]

Article first published online: 3 MAR 2013

DOI: 10.1029/2012GI054431

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Issue

Geophysical Research Letters

Volume 40, Issue 2, pages 359–364, 28 January 2013

Models leaf budburst across the eastern U.S. under climate scenarios; by the end of the century, species like red maple will leaf out 17 days earlier.

Global Change Biology

Primary Research Articles

**Changes in the structure and function of northern Alaskan ecosystems when considering variable leaf-out times across groupings of species in a dynamic vegetation model**

E.S. Euskirchen[1,*], T.B. Carman[1], A.D. McGuire[1,2]

DOI: 10.1111/gcb.12392

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Issue

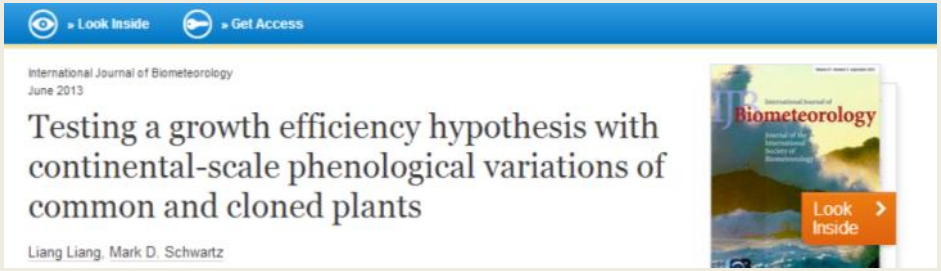
Global Change Biology

Accepted Article (Accepted, unedited articles published online and citable. The final edited and typeset version of record will appear in future.)

SEARCH

Advanced

Develops more precise models for changes in ecosystem function in Alaska, accounting for the phenology of individual species, rather than estimating an average day of year across species.



» Look Inside » Get Access

International Journal of Biometeorology

June 2013

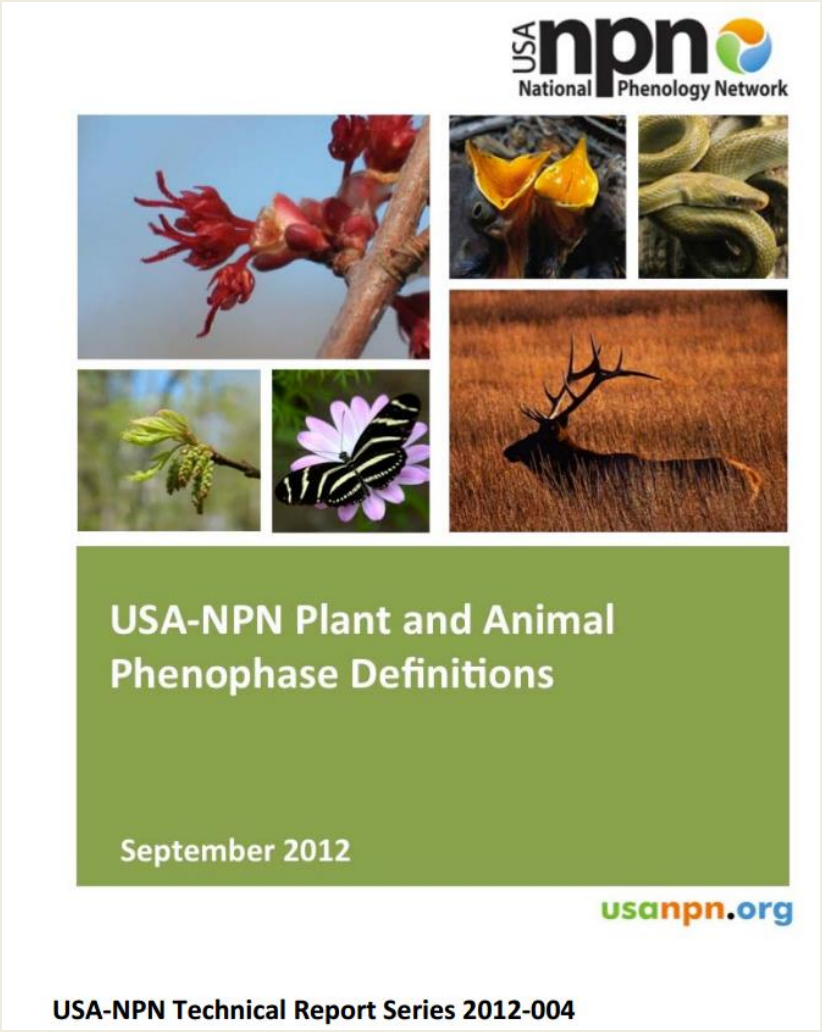
Testing a growth efficiency hypothesis with continental-scale phenological variations of common and cloned plants

Liang Liang, Mark D. Schwartz

Look Inside

Cloned plants had a more consistent response to warming spring temperatures than natural populations

# Stand-alone Protocols



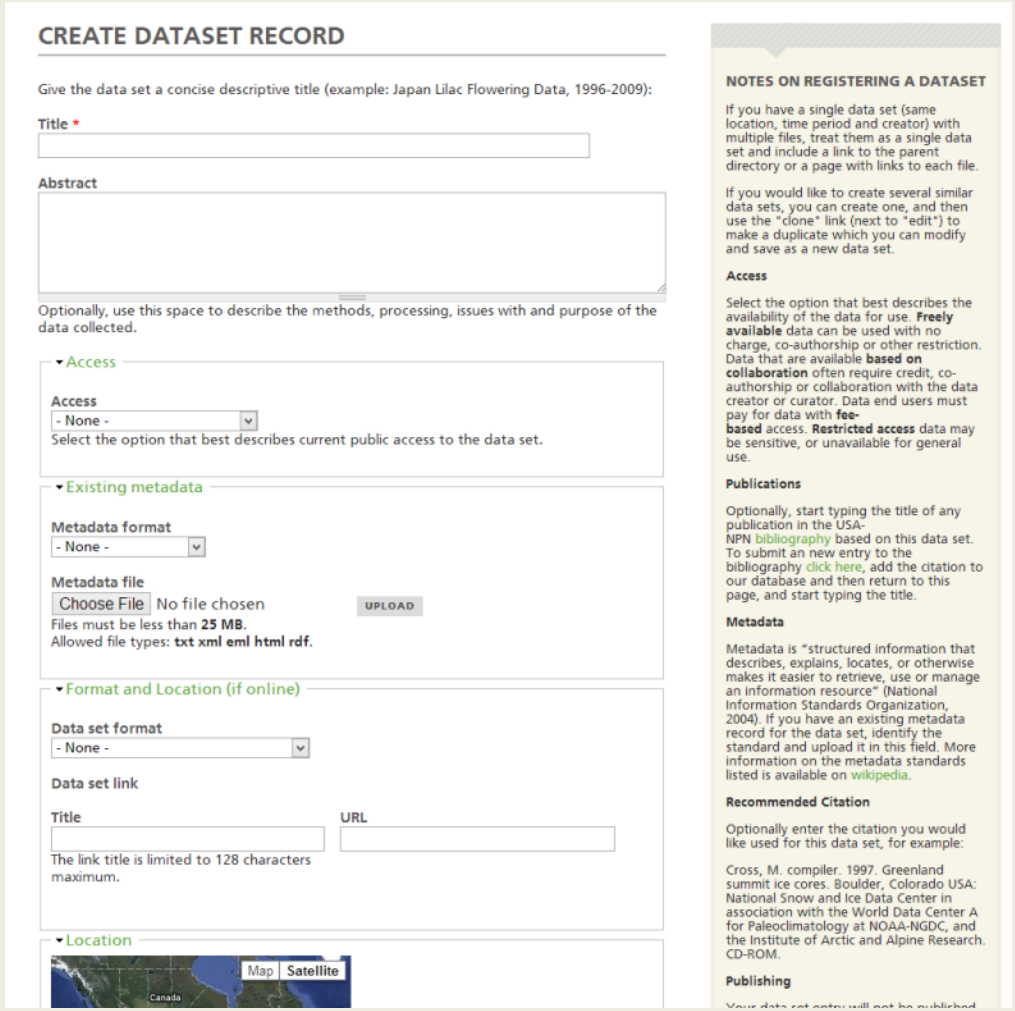

**SUMMARY TABLES**

**Angiosperms and Gymnosperms**

| | Phenophase title | Forb | Evergreen Forb | Grass/Sedge/Rush | Deciduous Tree/Shrub | Drought-deciduous Tree/Shrub | Broadleaf Evergreen Tree/Shrub | Cactus | Evergreen Conifer (excluding pines) | Pine | Deciduous Conifer |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vegetative phenophases | Initial growth | X | | X | | | | | | | |
| | Breaking leaf buds | | | | X | | X | | | | |
| | Young leaves | | X | | | X | X | | | | |
| | Leaves | X | | X | X | X | | | | | |
| | Increasing leaf size | | | | X | | | | | | |
| | Colored leaves* | | | | X | X | | | | | |
| | Falling leaves | | | | X | | | | | | |
| | Breaking needle buds | | | | | | | | X | | X |
| | Emerging needles** | | | | | | | | | X | |
| | Young needles | | | | | | | | X | X | |
| | Needles | | | | | | | | | | X |
| | Colored needles | | | | | | | | | | X |
| | Falling needles | | | | | | | | | | X |
| Reproductive phenophases | Flowers or flower buds*** | X | X | X | X | X | X | X | | | |
| | Open flowers | X | X | X | X | X | X | X | | | |
| | Pollen release**** | X | X | X | X | X | X | X | X | X | X |
| | Pollen cones | | | | | | | | X | X | X |
| | Open pollen cones | | | | | | | | X | X | X |
| Fruit/seed phenophases | Fruits | X | X | X | X | X | X | X | | | |
| | Ripe fruits | X | X | X | X | X | X | X | | | |
| | Recent fruit or seed drop | X | X | X | X | X | X | X | | | |
| | Unripe seed cones | | | | | | | | X | X | X |
| | Ripe seed cones | | | | | | | | X | X | X |
| | Recent cone or seed drop | | | | | | | | X | X | X |

* excluded for species with no noticeable color change leading up to leaf senescence
** "Emerging needles" is included for pines instead of "Breaking needle buds" in order to capture the period when needles unfold from their fascicle sheaths after the bud has broken and the candle has elongated
*** entitled "Flower heads" for grasses and sedges
**** in angiosperms, only included for allergen species in *Nature's Notebook*

# Register Legacy Phenology Data



CREATE DATASET RECORD

Give the data set a concise descriptive title (example: Japan Lilac Flowering Data, 1996-2009):

Title *

Abstract

Optionally, use this space to describe the methods, processing, issues with and purpose of the data collected.

Access

Access
- None -
Select the option that best describes current public access to the data set.

Existing metadata

Metadata format
- None -

Metadata file
Choose File No file chosen UPLOAD
Files must be less than **25 MB**.
Allowed file types: **txt xml eml html rdf**.

Format and Location (if online)

Data set format
- None -

Data set link

Title
The link title is limited to 128 characters maximum.

URL

Location
Map Satellite
Canada

NOTES ON REGISTERING A DATASET

If you have a single data set (same location, time period and creator) with multiple files, treat them as a single data set and include a link to the parent directory or a page with links to each file.

If you would like to create several similar data sets, you can create one, and then use the "clone" link (next to "edit") to make a duplicate which you can modify and save as a new data set.

**Access**

Select the option that best describes the availability of the data for use. **Freely available** data can be used with no charge, co-authorship or other restriction. Data that are available **based on collaboration** often require credit, co-authorship or collaboration with the data creator or curator. Data end users must pay for data with **fee-based** access. **Restricted access** data may be sensitive, or unavailable for general use.

**Publications**

Optionally, start typing the title of any publication in the USA-NPN bibliography based on this data set. To submit an new entry to the bibliography click here, add the citation to our database and then return to this page, and start typing the title.

**Metadata**

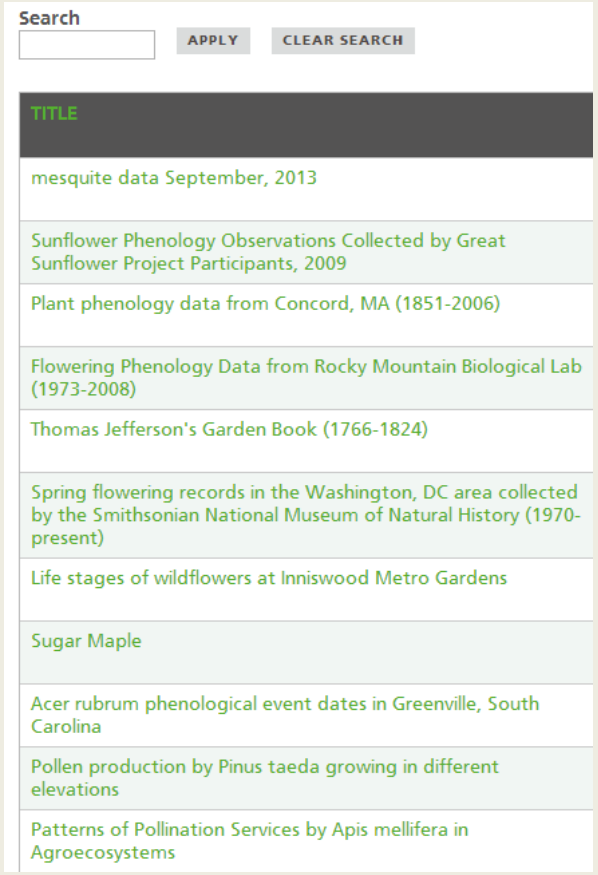
Metadata is "structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use or manage an information resource" (National Information Standards Organization, 2004). If you have an existing metadata record for the data set, identify the standard and upload it in this field. More information on the metadata standards listed is available on wikipedia.

**Recommended Citation**

Optionally enter the citation you would like used for this data set, for example:

Cross, M. compiler. 1997. Greenland summit ice cores. Boulder, Colorado USA: National Snow and Ice Data Center in association with the World Data Center A for Paleoclimatology at NOAA-NGDC, and the Institute of Arctic and Alpine Research. CD-ROM.

**Publishing**



Search

APPLY CLEAR SEARCH

TITLE

mesquite data September, 2013

Sunflower Phenology Observations Collected by Great Sunflower Project Participants, 2009

Plant phenology data from Concord, MA (1851-2006)

Flowering Phenology Data from Rocky Mountain Biological Lab (1973-2008)

Thomas Jefferson's Garden Book (1766-1824)

Spring flowering records in the Washington, DC area collected by the Smithsonian National Museum of Natural History (1970-present)

Life stages of wildflowers at Inniswood Metro Gardens

Sugar Maple

Acer rubrum phenological event dates in Greenville, South Carolina

Pollen production by Pinus taeda growing in different elevations

Patterns of Pollination Services by Apis mellifera in Agroecosystems

# Education Resources

ESSAY

IBI* SERIES WINNER

## A Season for Inquiry: Investigating Phenology in Local Campus Trees

Campus Trees, the IBI Prize–winning module, uses local phenology to create authentic inquiry experiences in undergraduate biology.

Tammy Long[1,†] and Sara Wyse[2]

Michigan State University rightfully claims one of the most beautiful campuses in the Midwest. Each spring, we anticipate a commencement gilded with tulips and crabapple blossoms. In autumn, the campus beams with golden oaks and fiery maples. As a potential subject for inquiry learning, phenology, the study of recurrent natural events, is appealing for many reasons.

Phenologic studies have relatively few logistical constraints compared with many topics in biology. Virtually every habitat imaginable undergoes cyclical or seasonal changes that can be observed through local plants, animals, or other organisms. Documenting phenological patterns can be a straightforward and cost-effective strategy for engaging students in the science of observation with little need for additional equipment or supplies.

The subject of phenology is both timely and scientifically relevant. Interannual variability in factors such as temperature and precipitation can shift the timing of phenologic events by days to months, with real-world impacts ranging from ecosystem function (e.g., plant-pollinator interactions) to regional economies (e.g., agriculture and tourism). Larger-scale trends over long periods of time serve as important indicators of environmental changes, including climate change (*1*).

Finally, phenology is complex. Seemingly simple processes, such as the changing color of leaves, actually result from myriad interactions occurring across molecular- to ecosystem-level scales. As a complex system, phenology encompasses multiple biological processes that can be explored from diverse disciplinary perspectives across scales of space and time (*2*, *3*) (see the first photo).

Our introductory labs are taught by graduate teaching assistants (TAs) ranging in both teaching experience and disciplinary

**Inquiry investigation.** Students worked with collaborative teams to develop in tifying leaf color change and abscission in campus trees. Most groups combine lower-tech approaches in their data collection strategy.

expertise. As the real face of the lab, TAs bear immediate responsibility for motivating student learning and bringing new instructional strategies into the classroom. They recognized that the labs we had been teaching, in which students followed protocols to confirm known outcomes, did not reflect the biology that motivated each of us to become biologists. We believed that in order to change both the content and culture of our labs, we would need to fully engage TAs as collaborators in the reform process.

In summer 2008, we invited TAs to a 2-day "boot camp" to learn about evidence-based teaching practices (*2*, *3*) and to provide input about goals for reforming labs. TAs said that labs should provide students opportunities to experience how science is done—not as a series of methodological steps, but as a way to ask questions, test ideas, and evaluate evidence. In addition, TAs wanted labs to be more authentic and to reflect the uncertainty of sci-

To incorporate th in small groups to framing them as inq explicit and measura Five TAs collaborate larger task of develo long phenology stu the second photo). I scientist model of t Network (*4*), we em of a long-term, stud documenting pheno

**Curriculum developers.** Graduate TAs.

[1]Department of Plant Biology, Michigan State University, East Lansing, MI 48824, USA. [2]Bethel University, St. Paul,

# Phenology trails

A phenology trail is a network of *Nature's Notebook* observation sites, which usually share species, a research and engagement goals.


Photo credit: L. Barnett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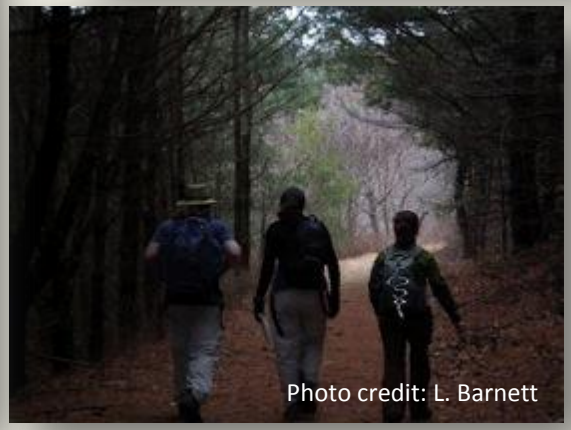
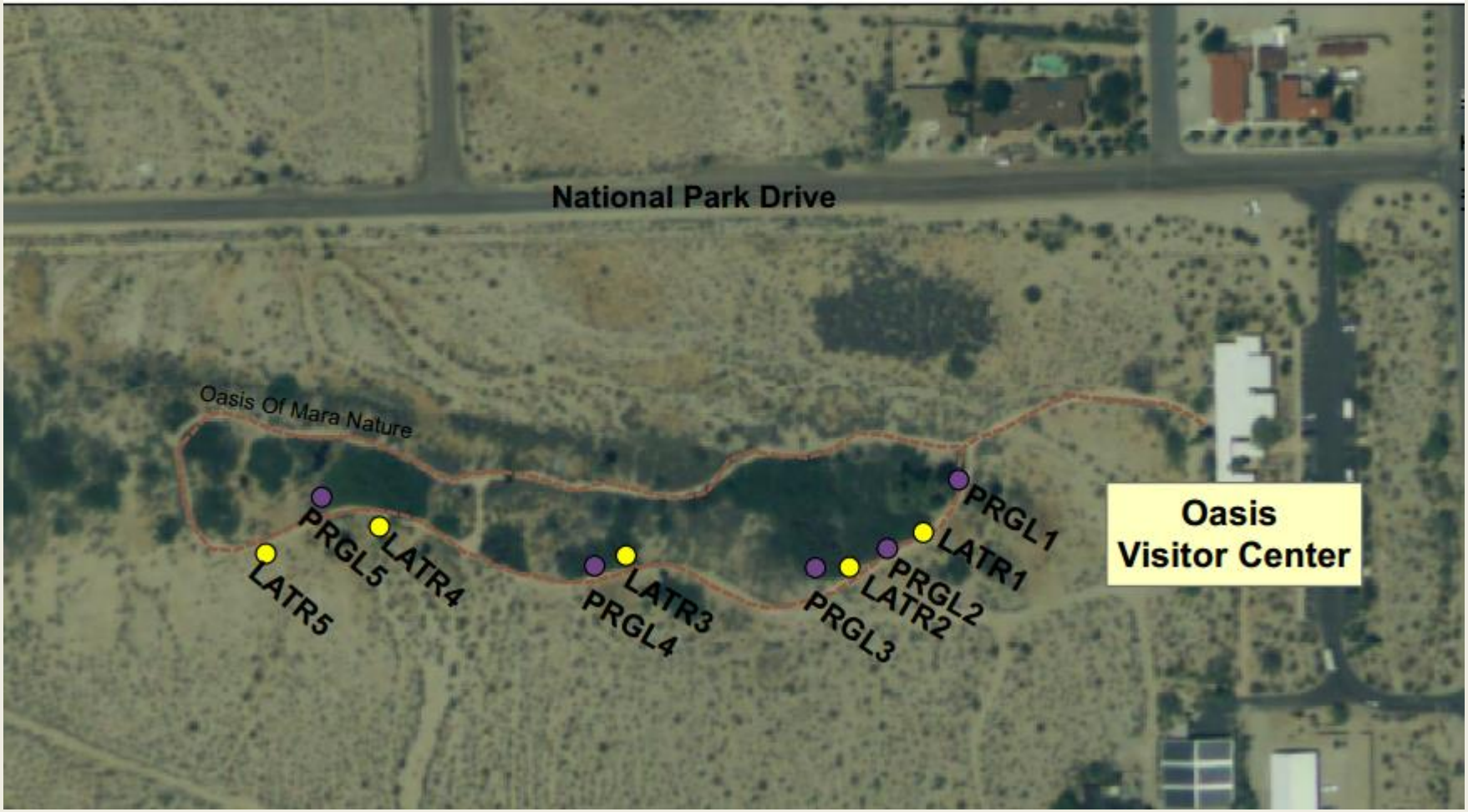


Photo credit: L. Barnett

# CPP JOTR Oasis Visitor Center Plants



# Tucson Phenology Trail

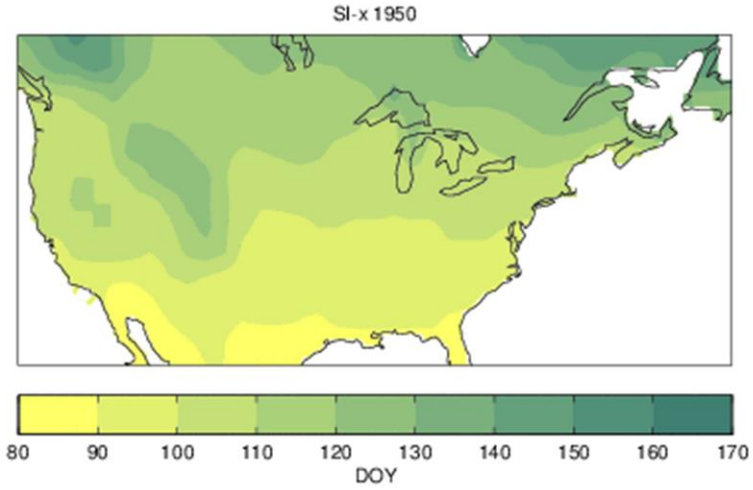

**Includes site at:**

- Biosphere 2
- University of Arizona Campus
- Sam Hughes Neighborhood
- Pima Extension Offices (2)
- Borton Elementary School
- Santa Rita Experimental Range
- Tucson Audubon Mason Center

Total of ~75 Miles
3-10 species tagged at each

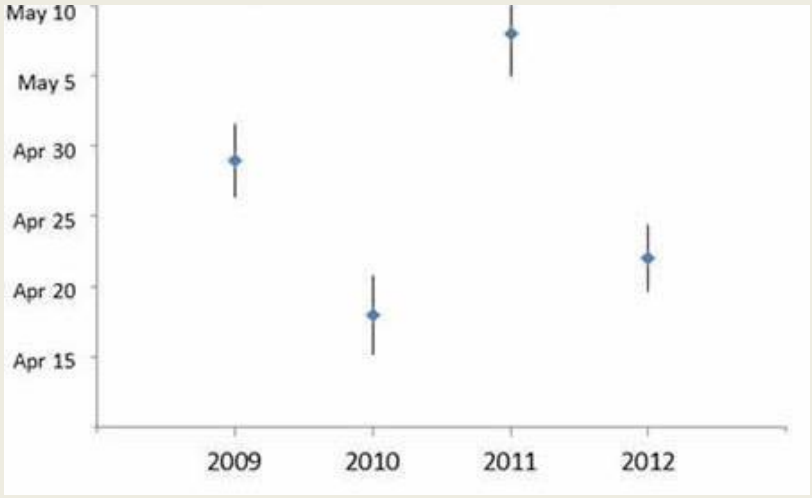
# Santa Rita Experimental Range

- Cloned lilac
  - Planted in 1950's as a bio-weather station
  - Used today to develop Spring Index models showing changes in onset of spring.
  - Currently part of the Tucson Phenology Trail, being monitored by Master Gardeners

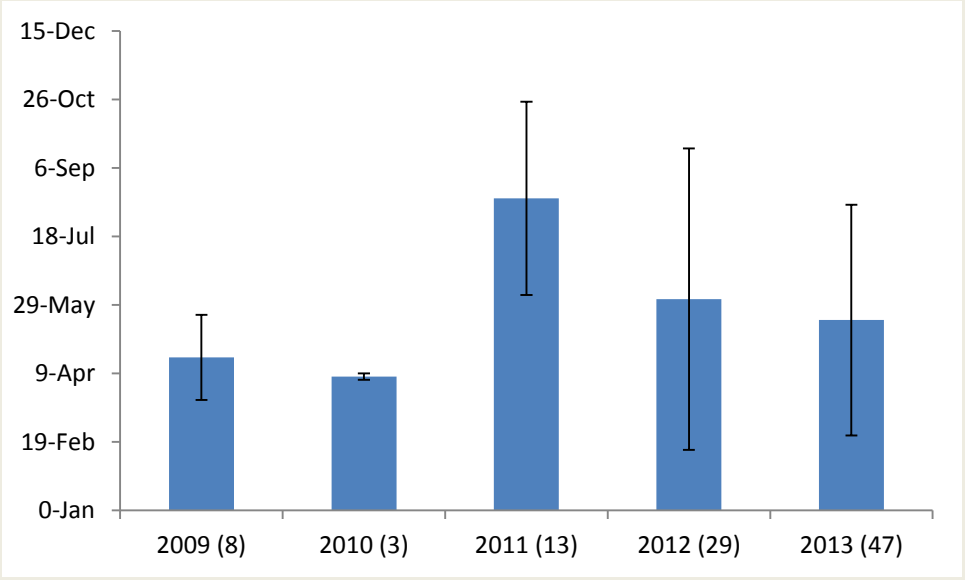



Credit: T. Ault

# Recent patterns in spring arrival



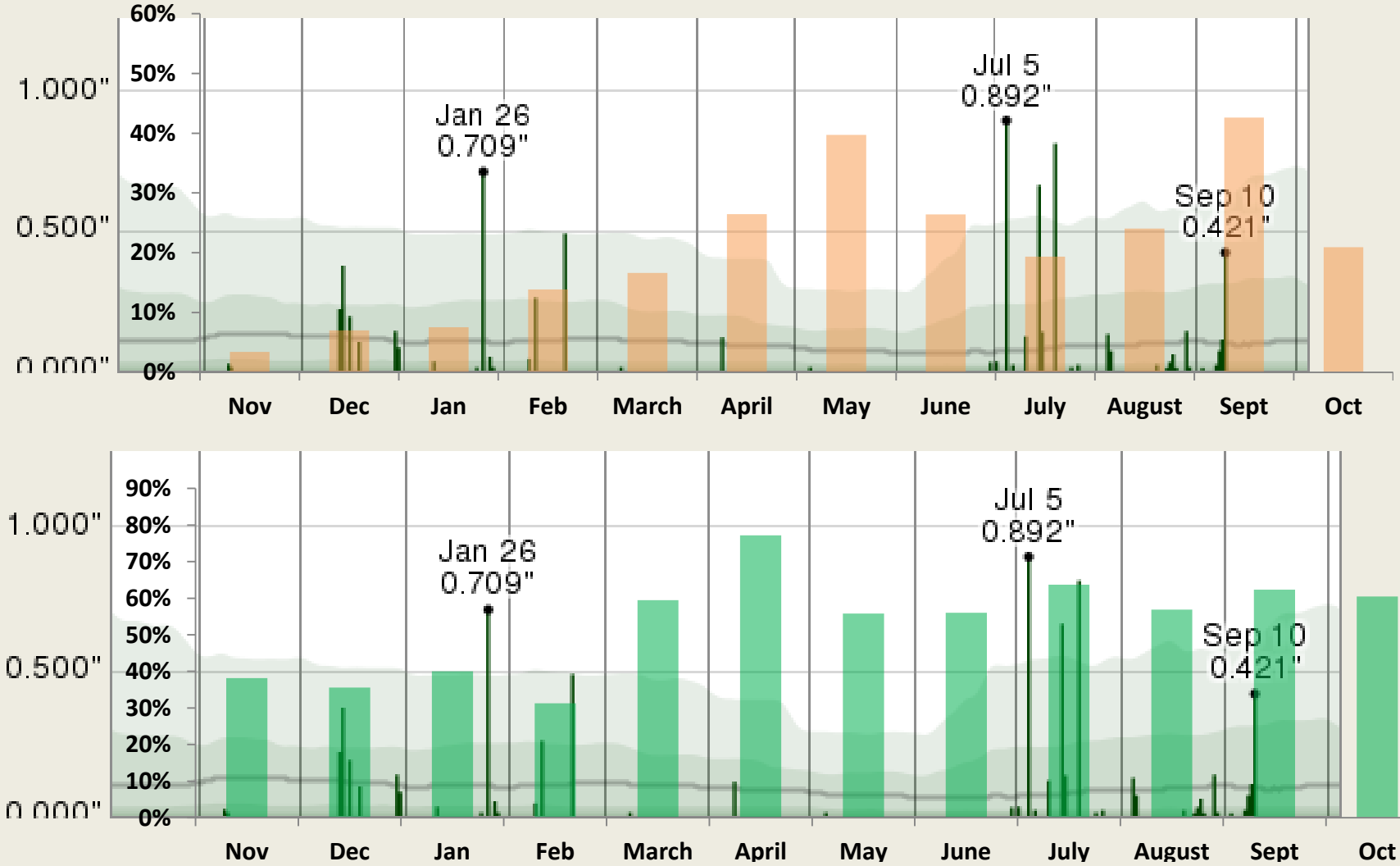

Mean leaf out date among 9 deciduous tree species in the northeastern United States.

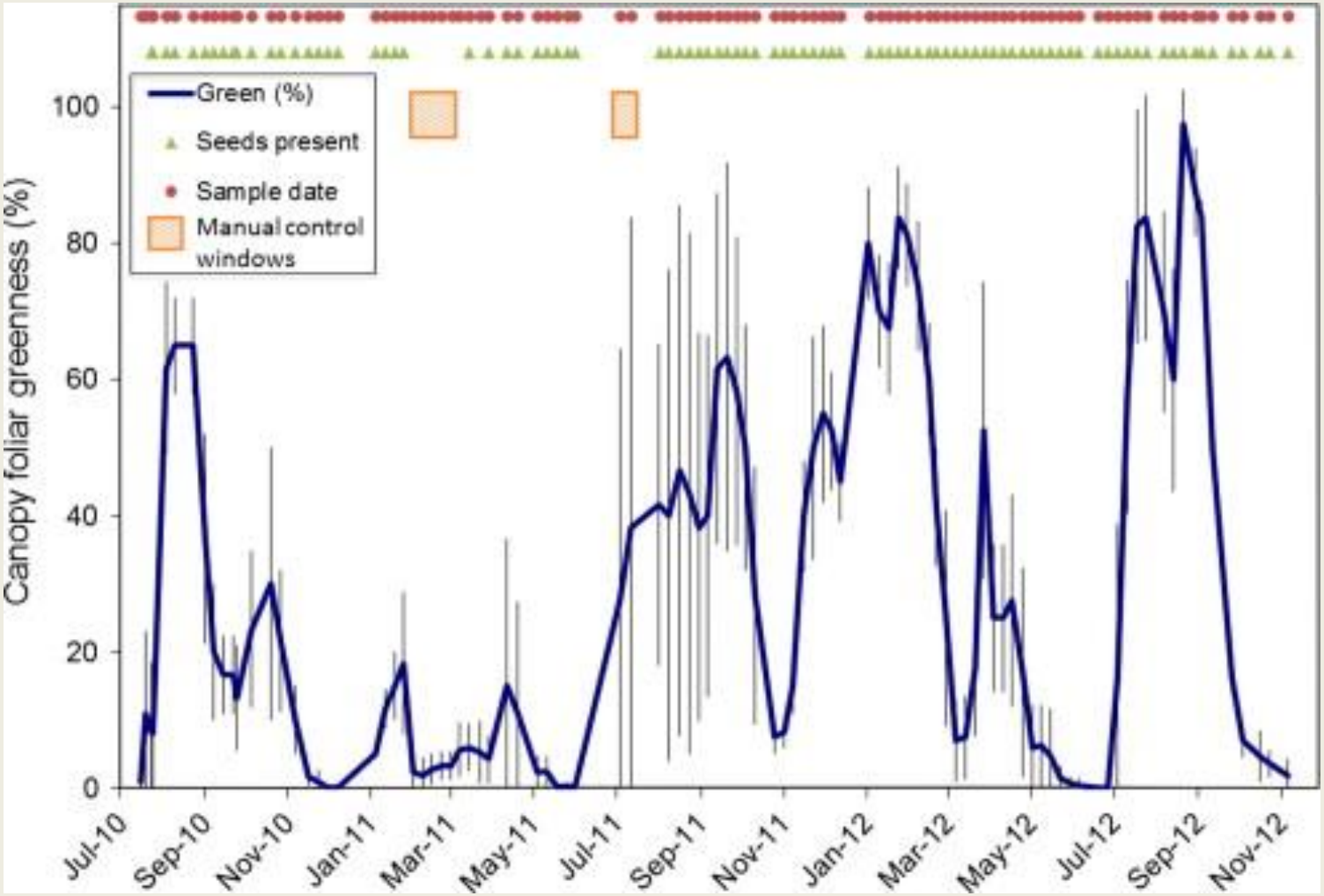



Mean leaf out date among 6 drought-deciduous tree species in the Tucson basin.

# Phenology in the Tucson Basin

Proportion of positive reports for flowering (top) and leafing (bottom) by month (Nov 2012-Oct 2013), and rainfall events in inches from the Historic Climate Network.






Buffelgrass phenology in Pima Canyon. Potential manual control windows on greenness peaks without seeds present (from Rosemartin et al 2013).

# Opportunities

- Use contemporary and legacy data
  - For phenology applications
  - As ancillary data for other questions
- Collaborate on proposals
- Register (rescue) legacy datasets
- Use USA-NPN protocols for new studies
- Use USA-NPN education materials for undergrad or adult audiences
- Use USA-NPN as a platform to collaborate across boundaries, locally, nationally or internationally

# Thank you!

## You're invited to connect with USA-NPN…

- Join the phenology community of practice, for research, education or management.
- Use NPN protocols, tools or data to advance your mission.
- Sign up for our quarterly newsletter.

usanpn.org

**Alyssa Rosemartin**

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